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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

[redacted]

11-18-2002
U.S. Patent & TMOfc/TM Mail Rcpt Dt. #70

In re Application of:
Caveo Networks, Inc.

Serial No.: 76/273,475

Filed: June 19, 2001

Mark: CAVIUM

International Class 9

Published:
February 19, 2002

ORIGINAL

Box TTAB Fee
Commission for Trademarks
2900 Crystal Drive
Arlington, VA 22202-3513

NOTICE OF OPPOSITION

Intel Corporation, a Delaware corporation, having its principal place of business at 2200 Mission College Boulevard, Santa Clara, California 95052 ("Opposer"), believes that it will be damaged by the registration of the alleged mark shown in Application Serial No. 76/273,475, filed by Caveo Networks, Inc., ("Applicant") and hereby opposes this application under the provisions of 15 U.S.C. §1063.

Application Serial No. 76/273,475 was filed as an intent to use application on June 19, 2001, for the alleged mark CAVIUM for "semiconductors, chipsets, processors, customized processors, chips for use in computer and network security applications, semiconductor chips and boards for use in servers, switches and routers for network and computer security" in Class 9. The application was published for opposition on February 19, 2002.

As grounds for the opposition, it is alleged that:

12/02/2002 KGIBBONS 00000141 083038 76273475

01 FC:6402 300.00 CH

P: 116438(2H%#011.DOC)

1. Opposer manufactures and sells a wide variety of high technology products and services, including computer hardware and software, technology integration products and services, and computer-related and communications-related services.

2. Since at least as early as 1993, Opposer has continuously manufactured and sold in interstate commerce microprocessors under the fanciful trademark PENTIUM, a coined term created by Opposer in 1992. Following the introduction of the original PENTIUM processor, Opposer established a series of PENTIUM marks, including PENTIUM PRO, PENTIUM MMX, PENTIUM II, PENTIUM II XEON, PENTIUM III, PENTIUM III XEON and PENTIUM 4. These marks have been used in association with Opposer's increasingly advanced microprocessors, including those released in 1997, 1999 and 2000.

3. Opposer is the owner of record of numerous trademark registrations and applications in the United States Patent and Trademark Office covering its PENTIUM mark, either with the PENTIUM mark standing alone or as part of a composite mark, for microprocessors, chipsets, motherboards, daughterboards, and many components used in PCs and laptops, computer services and a variety of related goods including clothing, jewelry, toys and games, bags, mugs and other accessories. Among the PENTIUM registrations are the following:

EXHIBIT	MARK	REG. NO.	REG. DATE	GOODS (CLASS)
A	PENTIUM	1,834,434	5/3/94	(Class 9)
B	PENTIUM	2,173,650	7/14/98	(Class 9)
C	PENTIUM	2,201,867	11/3/98	(Class 16)

EXHIBIT	MARK	REG. NO.	REG. DATE	GOODS (CLASS)
D	PENTIUM	2,257,967	6/29/99	(Class 14)
E	PENTIUM	2,250,489	6/1/99	(Class 21)
F	PENTIUM	2,250,493	6/1/99	(Class 25)
G	PENTIUM	2,261,579	7/13/99	(Class 28)
H	PENTIUM PROCESSOR (Stylized)	1,941,172	12/12/95	(Class 9)
I	PENTIUM	2,337,151	4/4/00	(Class 9)
J	INTEL INSIDE PENTIUM !!! & Design	2,377,327	8/15/00	(Class 9)
K	INTEL INSIDE PENTIUM PROCESSOR & Design	2,155,197	5/5/98	(Class 9)
L	PENTIUM	2,250,490	6/1/99	(Class 18)
M	PENTIUM	2,369,082	7/18/00	(Class 16)
N	PENTIUM II XEON	2,446,757	4/24/01	(Class 9)
O	PENTIUM	2,547,564	3/12/02	(Class 42)

Each of these registrations is currently valid and subsisting. Copies of all of these registrations are appended to this Notice of Opposition as Exhibits A-O. Further, Registration No. 1,834,434 is now incontestable under the provisions of 15 U.S.C. § 1065.

4. Moreover, for nearly 10 years, under the Intel Inside licensing program, Opposer has licensed its famous PENTIUM mark to thousands of licensees in the United States, including original equipment manufacturers (*i.e.* computer manufacturers such as Dell, Compaq and

Gateway) and retailers, for use on and in promotion of their personal computer systems and server products.

5. Opposer has invested hundreds of millions of dollars in the advertising and promotion of products sold under the PENTIUM marks over the last ten years. Through its extensive Intel Inside licensing program, Opposer's licensees have used Opposer's PENTIUM mark on their computers and shipping cartons, and in their advertising and promotional materials. Opposer's licensing program is a cooperative advertising program resulting in Intel's licensees' expenditure of additional hundreds of millions of dollars in advertising and promotional efforts that bear Opposer's PENTIUM mark.

6. As a consequence of its extensive sales and marketing efforts and advertising, promotion, and use of the PENTIUM marks, Opposer has developed enormous recognition of the PENTIUM marks and the products associated with them. The PENTIUM mark is famous, well known and widely recognized by the consumers in the U.S. and has acquired and now enjoys an immensely valuable reputation and tremendous goodwill under the mark.

7. Opposer also owns Registration No. 2,562,173 for ITANIUM in International Class 9, for goods including integrated circuits, microprocessors, computer hardware and computer software. A copy of this registration is appended to this Notice of Opposition as Exhibit P.

8. The ITANIUM mark is actively promoted and used and has been the recipient of extensive worldwide press coverage, thus gaining a broad reputation in the computer market. The ITANIUM mark is used on microprocessors and chips designed for use in computer and network security applications.

9. Both the PENTIUM mark and the ITANIUM mark are coined terms created by Opposer in 1992 and 1999 respectively, and both terms lack any dictionary meaning in the English language.

10. As a result of Opposer's extensive efforts in using and promoting its family of –IUM suffixed marks such as PENTIUM and ITANIUM, consumers have come to uniquely associate such –IUM marks with Opposer's goods, particularly with respect to microprocessors.

11. The dates of Opposer's first use and/or registrations of the above-referenced PENTIUM and ITANIUM marks long precede Applicant's June 19, 2001 filing date.

12. Applicant seeks registration for the alleged mark CAVIUM for semiconductors, chipsets, processors, customized processors, chips for use in computer and network security applications, semiconductor chips, and boards for use in servers, switches and routers for network and computer security.

13. Applicant is selling goods under the alleged CAVIUM mark that are identical to the Opposer's goods under the ITANIUM mark, including semiconductors (including those for use in servers), chipsets and processors for use with network security applications. Attached hereto as Exhibit Q is a copy of a white paper entitled "INTEL ITANIUM Processor High Performance on Security Algorithms" detailing the use of the ITANIUM mark on microprocessors for use with network security applications.

14. Applicant is selling goods under the alleged CAVIUM mark that are identical to the opposer's goods under the PENTIUM mark, including semiconductors, chipsets and processors. These semiconductors, chipsets and processors are designed to meet the performance requirements of security applications. Attached hereto as Exhibit R are copies of

articles demonstrating the use of the PENTIUM mark designed to meet the performance requirements of security applications.

15. Applicant's alleged CAVIUM mark so resembles Opposer's previously used and registered family of –IUM suffixed marks (the PENTIUM and ITANIUM marks) so as to be likely, when used in connection with the identified products of Applicant – chipsets, semiconductors, processors for use in computer and network security applications and for use in servers, switches and routers for network and computer security – to cause confusion, mistake, or to deceive.

16. As a result of the continuing and unique association between –IUM suffixed marks and the goods of Opposer, it is likely that the consumer could be misled into believing that Applicant's alleged CAVIUM mark is yet another mark in the Intel family of –IUM suffixed marks, especially since the goods provided under the CAVIUM mark, semiconductors, chipsets, processor chips for use in computer and network security applications and for use in servers, switches and routers for network and computer security, are identical to Opposer's goods

17. The Applicant's CAVIUM chip and the Opposer's ITANIUM or (in some cases) PENTIUM chips could be used together in a single server making confusion likely.

18. On information and belief, Applicant adopted CAVIUM with knowledge of Intel's famous PENTIUM mark and its ITANIUM mark with the intent to create an association, connection, and likelihood of confusion with Opposer.

19. Contrary to the suggestion created by the use of the alleged CAVIUM mark, Opposer is neither affiliated with nor a sponsor of Applicant, and the goods and services identified in the opposed application do not originate from Opposer.

20. Opposer's fanciful PENTIUM and ITANIUM and family of –IUM suffixed marks are of sufficient fame and have a sufficient reputation among consumers such that if and when Applicant's alleged CAVIUM mark is used on or in connection with the goods of Applicant, a false connection with Opposer would be presumed by consumers.

21. On information and belief, Applicant's proposed use of the alleged CAVIUM mark will falsely suggest a connection with Opposer. Because of the fame of Opposer's PENTIUM mark, ITANIUM mark and –IUM suffixed family of marks, built up at great expense to Opposer, and in light of identical goods offered by Opposer and Applicant as alleged herein, consumers are likely to be confused into believing that the goods associated with Applicant's alleged CAVIUM mark emanate from, or are associated with, or sponsored by Opposer.

22. On information and belief, Applicant's proposed use of the alleged CAVIUM mark will cause dilution of the distinctive quality of Opposer's famous PENTIUM mark, its ITANIUM mark, and its family of –IUM suffixed marks.

23. On information and belief, Applicant's proposed use of the alleged mark CAVIUM will blur and whittle away at the distinctiveness and identity-evoking quality of Opposer's PENTIUM and ITANIUM marks and its family of marks ending with the –IUM suffix.

The registration of Applicant's alleged CAVIUM mark on the Principal Register would be inconsistent with Opposer's rights under the aforementioned registrations, applications, and common law, and would be damaging to Opposer.

WHEREFORE, Opposer requests that Application Serial No. 76/273,475 be rejected, and that no registration be issued in connection with this application, and that this opposition be sustained in favor of Opposer.

Respectfully submitted,

INTEL CORPORATION

Date: November 18, 2002

By: Erica J Heibel

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CERTIFICATE OF EXPRESS MAIL

NUMBER EV 200889162 US

DATE OF DEPOSIT 11/18/02

I hereby certify that this paper or fee is being deposited with the United States Postal Service "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to: Assistant Commissioner for Trademarks, 2900 Crystal Drive, Arlington, VA 22202-3513.

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Ro Renojo

Int. Cl.: 9

Prior U.S. Cl.: 26

Reg. No. 1,834,434

United States Patent and Trademark Office

Registered May 3, 1994

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: COMPUTER HARDWARE; NAMELY, MICROPROCESSORS, IN CLASS 9 (U.S. CL. 26).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

SN 74-291,248, FILED 7-2-1992.

MIDGE BUTLER, EXAMINING ATTORNEY

EXHIBIT A

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36, and 38

United States Patent and Trademark Office

Reg. No. 2,173,650

Registered July 14, 1998

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: COMPUTER OPERATING SYSTEM SOFTWARE; COMPUTER OPERATING PROGRAMS; COMPUTER SYSTEM EXTENSIONS, TOOLS AND UTILITIES IN THE FIELD OF APPLICATION SOFTWARE FOR CONNECTING PERSONAL COMPUTERS, NETWORKS, TELECOMMUNICATIONS APPARATUS AND GLOBAL COMPUTER NETWORK APPLICATIONS; AUDIO AND VIDEO GRAPHICS FOR REAL TIME INFORMATION AND IMAGE TRANSFER, TRANSMISSION, RECEPTION, PROCESSING AND DIGITIZING; COMPUTER FIRMWARE; COMPUTER HARDWARE; COMPUTER PERIPHERALS; INTEGRATED CIRCUITS; INTEGRATED CIRCUIT CHIPS; SEMICONDUCTOR PROCESSORS; SEMICONDUCTOR PROCESSOR CHIPS; MICROPROCESSORS; PRINTED CIRCUIT BOARDS; ELECTRONIC CIRCUIT BOARDS; COMPUTER MEMORY DEVICES; SEMICONDUCTOR MEMORY DEVICES; VIDEO CIRCUIT BOARDS; AUDIO CIRCUIT BOARDS; AUDIO-VIDEO CIRCUIT BOARDS; VIDEO GRAPHIC ACCELERATORS; MULTIMEDIA ACCELERATORS; VIDEO PROCESSORS; FAX/MODEMS; COMPUTER HARDWARE AND SOFTWARE FOR THE TRANSMISSION AND RECEIPT OF FACSIMILES; COMPUTER HARDWARE AND SOFTWARE FOR THE DEVELOPMENT, MAINTENANCE, AND USE OF LOCAL AND WIDE AREA COMPUTER NETWORKS; COMPUTER HARDWARE AND SOFTWARE FOR THE DEVELOPMENT, MAINTENANCE, AND USE OF INTERACTIVE AUDIO-VIDEO COMPUTER CONFERENCE SYSTEMS; COMPUTER HARDWARE AND SOFTWARE FOR THE RECEIPT, DISPLAY, AND USE OF BROADCAST VIDEO, AUDIO, AND DIGITAL DATA SIGNALS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36 AND 38).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

OWNER OF U.S. REG. NOS. 1,834,434 AND 1,941,172.

SN 75-160,172, FILED 9-4-1996.

SOPHIA F. KIM, EXAMINING ATTORNEY

EXHIBIT B

Int. Cl.: 16

Prior U.S. Cls.: 2, 5, 22, 23, 29, 37, 38, and 50

Reg. No. 2,201,867

United States Patent and Trademark Office

Registered Nov. 3, 1998

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: PRINTED MATERIALS, NAMELY, BOOKS; MAGAZINES, NEWSLETTERS, JOURNALS, OPERATING MANUALS, USERS GUIDES, PAMPHLETS, AND BROCHURES ABOUT, FOR USE WITH AND DIRECTED TO USERS OF, COMPUTER OPERATING SYSTEM SOFTWARE; COMPUTER OPERATING PROGRAMS; COMPUTER SYSTEM EXTENSIONS; COMPUTER SYSTEM TOOLS; COMPUTER SYSTEM UTILITIES; COMPUTER APPLICATION SOFTWARE; COMPUTER FIRMWARE; COMPUTER HARDWARE; COMPUTER PERIPHERALS; COMPUTER COMPONENTS; INTEGRATED CIRCUITS; INTEGRATED CIRCUIT CHIPS; SEMICONDUCTOR PROCESSORS; SEMICONDUCTOR PROCESSOR CHIPS; MICROPROCESSORS; PRINTED CIRCUIT BOARDS; ELECTRONIC CIRCUIT BOARDS; COMPUTER MEMORY DEVICES; SEMICONDUCTOR MEMORY DEVICES; VIDEO CIRCUIT BOARDS; AUDIO CIRCUIT BOARDS; AUDIO-VIDEO CIRCUIT BOARDS; VIDEO GRAPHIC ACCELERATORS; MULTIMEDIA ACCELERATORS; VIDEO PROCESSORS; FAX/MODEMS; COMPUTER HARDWARE AND SOFTWARE FOR THE TRANSMISSION AND RECEIPT OF FACSIMILES; COMPUTER HARDWARE AND SOFTWARE FOR THE DEVELOPMENT, MAINTENANCE, AND USE OF LOCAL AND WIDE AREA COMPUTER NETWORKS; COMPUTER HARDWARE AND SOFTWARE FOR THE DEVELOPMENT, MAINTENANCE, AND USE OF INTERACTIVE AUDIO-VIDEO COMPUTER CONFERENCE SYSTEMS; COMPUTER HARDWARE AND SOFTWARE FOR THE RECEIPT, DISPLAY, AND USE OF BROADCAST VIDEO, AUDIO, AND DIGITAL DATA SIGNALS; AND COMPUTER HARDWARE AND SOFTWARE FOR DEVELOPMENT, TESTING, PROGRAMMING, AND PRODUCTION OF HARDWARE AND SOFTWARE, IN CLASS 16 (U.S. CLS. 2, 5, 22, 23, 29, 37, 38 AND 50).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

OWNER OF U.S. REG. NOS. 1,834,434 AND 1,941,172.

SN 75-160,171, FILED 9-4-1996.

SOPHIA S. KIM, EXAMINING ATTORNEY

Int. Cl.: 14

Prior U.S. Cls.: 2, 27, 28, and 50

Reg. No. 2,257,967

United States Patent and Trademark Office

Registered June 29, 1999

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: CLOCKS, BRACELETS, JEWELRY, CHARMS, CUFF LINKS, EARRINGS, KEY CHAINS, NECKLACES, NECKTIE FASTENERS, LAPEL PINS, MONEY CLIPS, PENDANTS, TIE PINS, TROPHIES AND WATCHES , IN CLASS 14 (U.S. CLS. 2, 27, 28 AND 50).

FIRST USE 4-0-1995; IN COMMERCE 4-0-1995.

SN 75-371,325, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

EXHIBIT D

Int. Cl.: 21

Prior U.S. Cls.: 2, 13, 23, 29, 30, 33, 40, and 50

Reg. No. 2,250,489

United States Patent and Trademark Office

Registered June 1, 1999

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: MUGS, SPORTS BOTTLES, IN CLASS 21 (U.S. CLS. 2, 13, 23, 29, 30, 33, 40 AND 50).

FIRST USE 4-0-1995; IN COMMERCE 4-0-1995.

SN 75-371,289, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

EXHIBIT E

Int. Cl.: 25

Prior U.S. Cls.: 22 and 39

Reg. No. 2,250,493

United States Patent and Trademark Office

Registered June 1, 1999

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: T-SHIRTS, SHIRTS, BEACHWEAR, LOUNGEWEAR, BOXER SHORTS, SWEATSHIRTS, SWEAT SUITS, COVERALLS, JACKETS, PANTS, SHORTS, TIES, BANDANNAS, HEADWEAR, FOOTWEAR, BOW TIES, CARDIGANS, GLOVES, HATS, JACKETS, JOGGING SUITS, NECKTIES, POLO SHIRTS, SCARVES, INFANT ROMPERS, VISORS, IN CLASS 25 (U.S. CLS. 22 AND 39).

FIRST USE 4-0-1995; IN COMMERCE 4-0-1995.

SN 75-371,547, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

Int. Cl.: 28

Prior U.S. Cls.: 22, 23, 38, and 50

Reg. No. 2,261,579

United States Patent and Trademark Office

Registered July 13, 1999

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: TOYS, NAMELY, STUFFED TOYS, PLUSH TOYS, DOLLS, BEAN BAGS, AND CHRISTMAS TREE ORNAMENTS, IN CLASS 28 (U.S. CLS. 22, 23, 38 AND 50).

FIRST USE 8-0-1997; IN COMMERCE 8-0-1997.

SN 75-371,361, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

EXHIBIT G

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36 and 38

United States Patent and Trademark Office

Reg. No. 1,941,172
Registered Dec. 12, 1995

TRADEMARK
PRINCIPAL REGISTER

pentium
PROCESSOR

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: COMPUTER HARDWARE, NAMELY MICROPROCESSORS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36 AND 38).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

OWNER OF U.S. REG. NO. 1,834,434.

NO CLAIM IS MADE TO THE EXCLUSIVE RIGHT TO USE "PROCESSOR", APART FROM THE MARK AS SHOWN.

SER. NO. 74-622,440, FILED 1-18-1995.

ADAM STRIEGEL, EXAMINING ATTORNEY

EXHIBIT H

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36 and 38

United States Patent and Trademark Office

Reg. No. 2,337,151

Registered Apr. 4, 2000

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: COMPUTERS; COMPUTER HARDWARE; COMPUTER FIRMWARE FOR USE IN OPERATING AND MAINTAINING THE COMPUTER SYSTEM; SEMICONDUCTORS; MICROPROCESSORS; INTEGRATED CIRCUITS; MICROCOMPUTERS; COMPUTER CHIPSETS; COMPUTER MOTHERBOARDS AND DAUGHTERBOARDS; COMPUTER GRAPHICS BOARDS; COMPUTER NETWORKING HARDWARE; COMPUTER NETWORK ADAPTORS, SWITCHES, ROUTERS AND HUBS; COMPUTER PERIPHERALS AND ELECTRONIC APPARATUS FOR USE WITH COMPUTERS; KEYBOARDS; TRACKBALLS; COMPUTER MOUSE DEVICES; COMPUTER INPUT DEVICES; COMPUTER MONITORS; VIDEO APPARATUS; VIDEO CIRCUIT BOARDS; APPARATUS AND EQUIPMENT FOR RECORDING, PROCESSING, RECEIVING, REPRODUCING, TRANSMITTING, MODIFYING, COMPRESSING, DECOMPRESSING, BROADCASTING, MERGING AND/OR ENHANCING SOUND, VIDEO IMAGES, GRAPHICS, AND DATA; ALGORITHM SOFTWARE PROGRAMS FOR THE OPERATION AND CONTROL OF COMPUTERS; COMPUTER COMPONENT TESTING AND CALIBRATING ELECTRONIC UNITS; SET-TOP BOXES, NAMELY, ELECTRONIC CONTROL BOXES FOR THE INTERFACE AND CONTROL OF COMPUTERS AND GLOBAL COMPUTER NETWORKS WITH TELEVISION AND CABLE BROADCASTS AND EQUIPMENT; COMPUTER PROGRAMS FOR NETWORK MANAGEMENT; COMPUTER UTILITY PROGRAMS; COMPUTER OPERATING SYSTEM SOFTWARE; COMPUTER PROGRAMS FOR RECORDING, PROCESSING, RECEIVING REPRODUCING, TRANSMITTING, MODIFYING, COMPRESSING, DECOMPRESSING, BROADCASTING, MERGING, AND/OR ENHANCING SOUND, VIDEO, IMAGES, GRAPHICS, AND DATA; COMPUTER PROGRAMS FOR WEB PAGE DESIGN; COMPUTER PROGRAMS FOR ACCESSING AND USING THE GLOBAL COMPUTER NETWORKS; TELECOMMUNICATIONS APPARATUS AND INSTRUMENTS; APPARATUS AND EQUIPMENT FOR USE IN VIDEO-CONFERENCING, TELECONFERENCING, DOCUMENT EXCHANGE AND EDITING; CAMERAS AND DIGITAL CAMERAS FOR USE WITH COMPUTERS; HEADSETS FOR USE WITH COMPUTERS, COMPUTER SOFTWARE, VIDEOCONFERENCING EQUIPMENT AND TELECONFERENCING EQUIPMENT; PARTS, FITTINGS, AND TESTING APPARATUS FOR ALL THE AFORESAID GOODS; AND USER MANUALS FOR USE WITH, AND SOLD AS A UNIT WITH, ALL THE AFORESAID GOODS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36 AND 38).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

OWNER OF U.S. REG. NOS. 1,834,434 AND 1,941,172.

SER. NO. 75-412,487, FILED 12-31-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

EXHIBIT I

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36 and 38

United States Patent and Trademark Office

Reg. No. 2,377,327

Registered Aug. 15, 2000

TRADEMARK
PRINCIPAL REGISTER

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: COMPUTER HARDWARE, INCLUDING INTEGRATED CIRCUITS, MICROPROCESSORS, AND OTHER SEMICONDUCTOR DEVICES; COMPUTERS; COMPUTER WORKSTATIONS; NOTEBOOK AND LAPTOP COMPUTERS; PORTABLE COMPUTERS; MICROCOMPUTERS; SERVERS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36 AND 38).

FIRST USE 2-0-1999; IN COMMERCE 2-0-1999.

OWNER OF U.S. REG. NOS. 1,702,463, 2,188,280 AND OTHERS.

SER. NO. 75-746,763, FILED 7-8-1999.

F. D. CARMINE, EXAMINING ATTORNEY

EXHIBIT J

Int. Cl.: 9

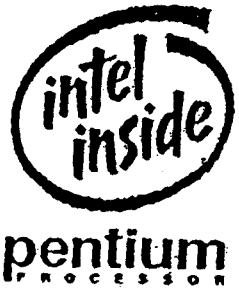
Prior U.S. Cls.: 21, 23, 26, 36, and 38

Reg. No. 2,155,197

United States Patent and Trademark Office

Registered May 5, 1998

TRADEMARK
PRINCIPAL REGISTER



INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 950528119

FOR: COMPUTER HARDWARE, NAMELY, MICROPROCESSORS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36 AND 38).

FIRST USE 5-0-1993; IN COMMERCE 5-0-1993.

OWNER OF U.S. REG. NOS. 1,702,463, 1,705,796, AND 1,941,172.

NO CLAIM IS MADE TO THE EXCLUSIVE RIGHT TO USE "PROCESSOR", APART FROM THE MARK AS SHOWN.

SN 74-716,085, FILED 8-8-1995.

K. MARGARET LE, EXAMINING ATTORNEY

EXHIBIT K

Int. Cl.: 18

Prior U.S. Cls.: 1, 2, 3, 22, and 41

Reg. No. 2,250,490

United States Patent and Trademark Office

Registered June 1, 1999

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: TRAVEL BAGS, LUGGAGE, SCHOOL BAGS, BACK PACKS, BEACH BAGS, DUFFEL BAGS, FANNY PACKS, UMBRELLAS, IN CLASS 18 (U.S. CLS. 1, 2, 3, 22 AND 41).

FIRST USE 5-0-1998; IN COMMERCE 5-0-1998.

SN 75-371,290, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

EXHIBIT L

Int. Cl.: 16

Prior U.S. Cls.: 2, 5, 22, 23, 29, 37, 38, and 50

Reg. No. 2,369,082

United States Patent and Trademark Office

Registered July 18, 2000

TRADEMARK
PRINCIPAL REGISTER

PENTIUM

INTEL CORPORATION (DELAWARE CORPORATION)
2200 MISSION COLLEGE BLVD.
SANTA CLARA, CA 95052

FOR: BINDERS, BOOKENDS, BOOKMARKERS, BOXES FOR PENS, CALENDERS, TABLETS, NOTE CARDS AND PLAYING CARDS, SELF-ADHESIVE PADS, DESK PADS, AND CALENDER PADS, PENS, PENCILS, FOLDERS, PAPERWEIGHTS, PENCIL HOLDERS, PHOTOGRAPH STANDS, RULERS, GIFT WRAP, ERASERS, MARKERS, CRAYONS, CHALK, DESK SETS, DESK ORGANIZERS, BUMPER STICKERS, IN CLASS 16 (U.S. CLS. 2, 5, 22, 23, 29, 37, 38 AND 50).

FIRST USE 4-0-1997; IN COMMERCE 4-0-1997.

SN 75-371,273, FILED 10-10-1997.

NANCY L. HANKIN, EXAMINING ATTORNEY

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36, and 38

Reg. No. 2,446,757

United States Patent and Trademark Office

Registered Apr. 24, 2001

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FIRST USE 6-0-1998; IN COMMERCE 6-0-1998.

PRIORITY CLAIMED UNDER SEC. 44(D) ON FED REP GERMANY APPLICATION NO. 398025266, FILED 1-20-1998, DATED 0-0-0000.

OWNER OF U.S. REG. NOS. 1,834,434, 2,201,867, AND OTHERS.

SN 75-505,341, FILED 6-19-1998.

LAURIEL DALIER, EXAMINING ATTORNEY

Exhibit N

Int. Cl.: 42

Prior U.S. Cls.: 100 and 101

United States Patent and Trademark Office

Reg. No. 2,547,564
Registered Mar. 12, 2002

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FIRST USE 1-0-1999; IN COMMERCE 1-0-1999.

OWNER OF U.S. REG. NOS. 1,834,434 AND 1,941,172.

SN 75-412,486, FILED 12-31-1997.

PAUL F. GAST, EXAMINING ATTORNEY

EXHIBIT O

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36, and 38

United States Patent and Trademark Office

Reg. No. 2,562,173

Registered Apr. 16, 2002

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FIRST USE 5-29-2001; IN COMMERCE 5-29-2001.

PRIORITY CLAIMED UNDER SEC. 44(D) ON FED REP GERMANY APPLICATION NO. 39853087.4, FILED 9-16-1998, DATED 0-0-0000.

SN 75-660,120, FILED 3-15-1999.

ODESSA BIBBINS, EXAMINING ATTORNEY

EXHIBIT P

Intel® Itanium™ Processor

High Performance On Security Algorithms (RSA Decryption Kernel)

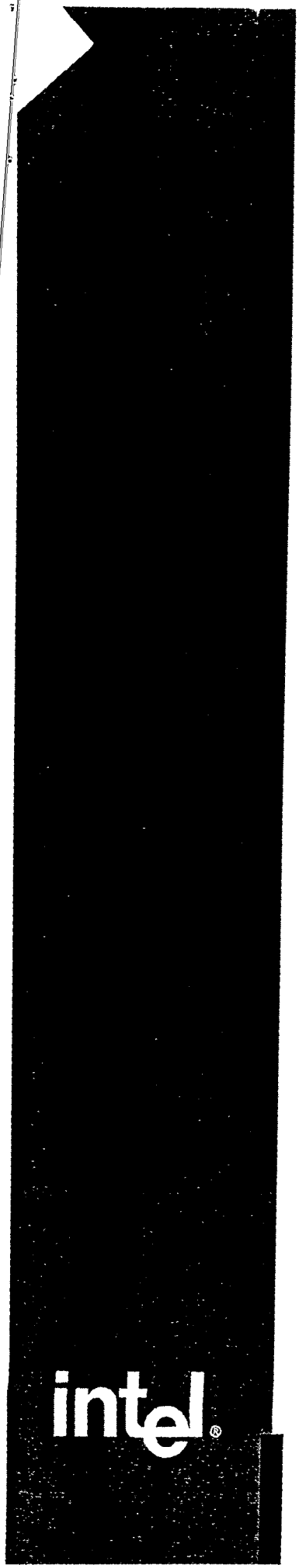


EXHIBIT Q

Executive Summary

The tremendous growth of the Internet has resulted in an explosion of e-Commerce Web sites. As e-Commerce continues to grow exponentially, security becomes a major issue on the minds of IT managers everywhere.

To secure the e-Commerce environment, companies must deploy solutions at various levels within their computing environment and integrate them into their applications. Web sites use software that relies on security algorithms and protocols to authenticate identities, protect data and monitor transactions. One type of security algorithm is public-key cryptography, which is used widely in Internet-based security technologies. Common protocols such as Secure Sockets Layer (SSL), Public Key Infrastructures (PKI) and Virtual Private Networks (VPN) are examples of security technologies that rely on algorithms based on public-key cryptography. Despite the widespread reliance on these algorithms, however, they do have one significant drawback: They are very compute-intensive and known to have a significant impact on server performance. This is especially true in the case of short transactions, which are typical of e-Commerce.

The Intel® Itanium™ processor, based on the IA-64 architecture, has several features that can help to speed up public-key cryptography. Parallel instruction issue, multiple execution units, 64-bit Integer Multiply-Add instruction, and a large register set enable high performance on public-key cryptography algorithms. Using optimistic performance estimates for competitive products (based on theoretical analyses of their respective instruction sets and architecture) and comparing with actual performance on the Itanium processor, the Itanium processor is nearly 10 times faster than the Sun UltraSPARC III† processor.

The Itanium processor provides performance leadership in executing the public-key algorithms needed for secure e-Commerce transactions, and does so without special hardware assistance. This is an advantage because hardware solutions are costly and increase the form factor of the total server solution.

Because of the potential security vulnerabilities posed by e-Commerce, Web sites need the protection of security-specific software even though such software is widely known to degrade server performance. Until recently, IT managers have been forced to live with the performance trade-off or resort to expensive hardware solutions. Now, performance advancements provided by the Itanium processor enable the integration of additional security features into application software without compromising server performance. This means IT managers can finally eliminate the trade-off between performance and security.

Table 1. RSA 1024-bit Decryption Performance Comparison

Processor	Clock Frequency	RSA Decryptions Per Second
Itanium™ Processor	660 MHz	1,000*
Sun UltraSPARC III™	600 MHz	130**

* Measured Performance
** Estimate of best case performance based on theoretical analysis

Table of Contents

RSA Decryption Kernel Measurements

Background

To ensure that e-Commerce sites are secure, Web sites use security algorithms and protocols to authenticate identities, authorize access, protect data, ensure transaction integrity and monitor and audit transactions. One type of security algorithm is public-key cryptography, which is widely used in Internet-based security technologies.

Public-key cryptography is also known as asymmetric-key cryptography and, as such, differs from symmetric-key cryptography. In symmetric-key cryptography, there is one key, used by the sender for encryption and by the receiver for decryption. This approach introduces potential problems with key distribution. In public-key (or asymmetric-key) cryptography, there are two keys: a public key known to all and a private key known only to the key owner. This approach eliminates any key-

distribution problems since the public key does not need to be hidden. The downside, however, is that compared with symmetric-key cryptography, public-key cryptography is very computationally intensive, which inhibits its use for encrypting large volumes of data. Therefore, the two forms of cryptography are generally used in tandem. The keys for symmetric encryption are exchanged using public-key cryptography, and the actual message is exchanged using the symmetric keys. The most commonly used implementations of public-key encryption are the RSA public-key algorithm, patented by RSA Security Inc., and the protocol known as Secure Sockets Layer (SSL). Some other security technologies that rely on public-key cryptography are Public Key Infrastructures (PKI) and Virtual Private Networks (VPN).

The RSA Algorithm

Named after its inventors (Rivest, Shamir, Adelman) and offered by RSA Security Inc., the RSA algorithm is the most widely used public-key algorithm. It also is computationally intensive. At the core of the computation is the exponentiation of large numbers to large powers. The encryption of a single small message may cost millions of native processor operations. There are alternatives to using the RSA algorithm for public-key encryption, but virtually all of them use a large number multiplication at their core.

To understand large number multiplication, consider computation of the quantity $\mathbf{M^e \bmod n}$, where each of the values is a very large integer, typically 512 or 1024 bits in length. The mod (or modulo) operation computes the remainder after division and is commonly referred to as a reduction, since it reduces the number to be less than **n**. Since the exponent is so large, it is obviously not feasible to complete all of the exponentiation before doing the reduction, because the resulting number would have an astronomical number of bits. So in practice the multiplication steps are interleaved with reductions after each multiplication. The long division used for reduction is a very expensive operation, though, if done by repeated trial division, as by hand.

In 1985, a researcher named Peter Montgomery published a method for doing the multiplication and reduction that does not require trial division. Now known as the Montgomery Product, this method allows the multiplication and reduction to be done as a series of multiplications and additions. The Montgomery Product is used widely for doing modular exponentiation. An excellent summary of the Montgomery Product (and the methods for optimizing it) can be found in [4]. This calculation takes up about 50% of the time required to complete a short secure transaction (typical of e-Commerce).

Secure Sockets Layer

Secure Sockets Layer (SSL) is another important implementation of public-key cryptography. The SSL protocol was originally developed by Netscape and has been widely accepted for authenticated and encrypted communication between clients and servers on the Web [4]. The SSL protocol has three main purposes:

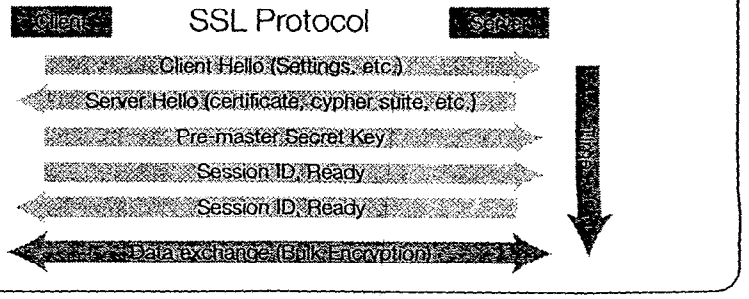
- Server authentication
- Client authentication
- Secure private communications

Server authentication is used to confirm the identity of the server and relies on certificate authorities as a source of trusted information about valid certificates. Client authentication is used to confirm the identity of the client. Though not yet used widely, its use is likely to rise to deal with credit card fraud issues. Secure private communications use encryption to send and receive information.

The SSL protocol uses a combination of public-key and symmetric-key encryption. Symmetric-key encryption is much faster than public-key encryption, but public-key encryption provides more robust authentication techniques. An SSL session always begins with an exchange of messages called the SSL handshake. The handshake allows the server to authenticate itself to the client using public-key techniques, and then allows the client and the server to cooperate in the creation of symmetric keys used for rapid encryption, decryption and tamper detection during the session that follows. Optionally, the handshake also allows the client to authenticate itself to the server. The figure below shows the sequence (from top to bottom) of the basic SSL protocol.

SSL is widely known to degrade server performance. From the article "E-Biz

Figure 1. SSL Protocol



Bucks Lost Under SSL Strain" in Internet Week [1], "Recent tests conducted by researcher Networkshop Inc. indicate that powerful Web servers capable of handling hundreds of transactions per second may be brought to a near stand-still by heavy SSL traffic. Some server configurations suffered as much as a fifty-fold degradation in performance from SSL, down to just a few transactions per second, according to analyst Alistair Croll at Networkshop."

Figure 2 shows the contribution of the RSA computation (public-key operations), symmetric data encryption and miscellaneous computations for the transfer of a file of a given size under the SSL protocol. Note that for smaller files, the RSA computation contributes the most time. These results are based on analyses by Intel.

Benefits of Security Algorithm Performance

As previously noted, the impact of security on server performance has been widely reported, particularly in the context of SSL transactions. As Figure 2 shows, a primary source of the performance impact is in the public-key operations. In the past, there were two primary means of addressing this bottleneck: (1) purchasing more servers or (2) using special-purpose hardware to do the public-key computations. Each of these solutions adds cost, both direct (purchase price) and indirect (increased complexity, larger footprint).

SSL and other implementations based on public-key cryptography can be expected to have high performance on Itanium processor-based systems. Such performance should enable an increase in server capacity and a decrease in server-response time. The actual capacity increase depends significantly on both the mix of secure vs. non-secure transactions and the size of the transactions. In the best case, we expect to see server capacity to increase by upward of 40 percent over untuned software. This case will apply when there are a high number of short secure transactions. The cost of authentication is incurred only once during a normal SSL transaction. A session may be quite lengthy (e.g., from login to logout), and SSL allows this entire session to be conducted under one authentication. In this case the capacity increase may be minimal.

The improvements in response time are much harder to analyze but are potentially much more dramatic. Since most servers are tuned to operate not at peak capacity but at some average capacity, a significant burst of secure transactions can cause server queues to grow quickly and cause a dramatic increase in response time. The fast authentication capability of the Itanium processor provides faster service times for the queues, thus reducing the potential for unstable situations where the queue is growing faster than it is being serviced. Of course, the benefit will be less apparent when the server is receiving transactions well beneath its capacity.

Several useful discussions of this phenomenon can be found at the Rainbow Technologies ISG Labs Web site at http://isglabs.rainbow.com. (Rainbow is a supplier of cryptographic hardware. We believe that its arguments about the impact of performance improvements in public-key algorithms are valid also for the improvements we have realized on the Itanium processor.)

Test Results

To obtain all performance measurements on the Itanium processor, we used a proprietary test application from RSA Security Inc. This test application was linked with an early version of a security library that RSA Security plans to release.

Based on our analyses of the Montgomery Product, we can now either directly measure or estimate RSA public-key performance. Also included in those analyses is performance data for the Sun UltraSPARC III processor.

Figure 2. Relative component costs for SSL transactions of various sizes

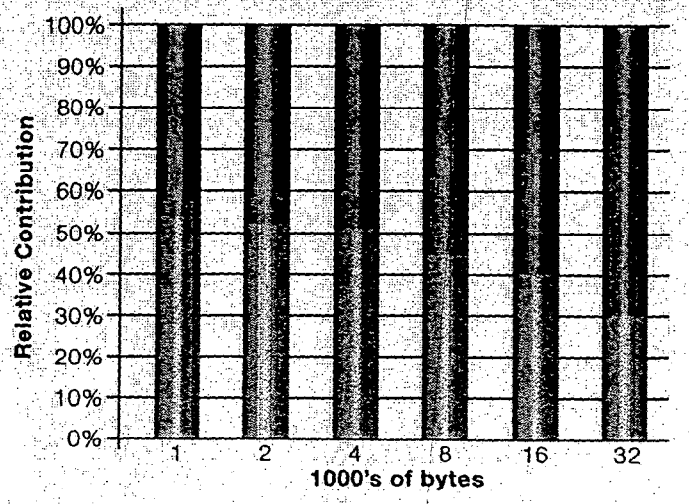


Table 2. RSA 1024-bit Decryption Performance Comparison

Processor	Clock Frequency	RSA Decryptions Per Second
Itanium™ Processor	660 MHz	1,000*
Sun UltraSPARC-III™	600 MHz	130**

* Measured Performance
** Estimate of best case performance based on theoretical analysis

Please note that the measurement results provided in this report are preliminary and were derived from testing done on pre-production hardware. These results do not reflect the performance of the final production-level systems and should not be used to estimate or project production-level performance.

Also note that both software and hardware are expected to change over time, which will change the performance of the system. Finally, performance results may vary considerably depending on the specific workload. The performance gains on particular algorithms will not give the same degree of overall application performance improvement. In particular, the performance gains cited in this report are most relevant in workloads with a high percentage of short, secure transactions.

The Intel® Itanium™ Processor and the Montgomery Product

The Itanium processor has several features that help to accelerate the performance of the Montgomery Product. These include parallel instruction issue, multiple execution units (four integer, four multimedia, two floating-point, two memory and three branch units), large register set and the 64-bit Integer Multiply-Add Instruction (xma).

The 64-bit Integer Multiply-Add instruction produces the upper or lower 64-bit product, executes on either floating-point execution unit, and is fully pipelined. The large register set allows the Montgomery Product operands and intermediate results to be held in registers rather than in memory.

Table 3 shows the parallel instruction execution in the Itanium processor. The algorithm maps into the architecture efficiently, allowing full use of all functional units for the bulk of this computation. This parallel instruction execution continues for most of the Montgomery Product computation.

Table 4 summarizes the Montgomery Product performance results.

Performance of Other Platforms

The Montgomery Product can also be used to compare processor performance. Examining the architecture and implementation details of various microprocessors, their Montgomery Product performance estimates can be calculated. In particular, a performance estimate can be made by comparing the number of integer multipliers, latency of the multipliers, whether or not the multipliers are pipelined, types of integer multiply instructions, number of ALU execution units and number of instructions issued per clock.

The performance of the Itanium processor on the Montgomery Product is compared with the performance of the following processors:

- Compaq Alpha 21264/21364 processors (Ref. 7)
- Sun UltraSPARC III processor (Ref. 9)
- IBM PowerPC 7400 (G4) processor with AltiVec (or Velocity Engine) (Ref. 12)

(Note that the documents used to derive these estimates are listed in the reference section of this document.)

The Alpha architecture defines upper and lower integer multiply instructions much like the IA-64 architecture's xmul.u and xmul.l upper and lower integer multiply instructions (but without the multiply-and-add feature). The Alpha 21264/21364 has a single pipelined 64-bit integer multiplier, as compared with the Itanium processor dual pipelined integer multipliers.

The SPARC architecture defines only a single MULX instruction, which multiplies two 64-bit integer values and produces a 64-bit result. There is no method for capturing the upper 64 bits of the result.

Table 3. Itanium™ Processor Parallel Instruction Execution

Unit	Instruction	Function
FPU 0	xma.lu	Integer Multiply with Add
FPU 1	xma.hu	Integer Multiply with Add
Integer 0	Add	Add Partial Products
Integer 1	p = cmp.ltu	Integer Compare for Carry
Memory 0	getf.sig	Move Partial Product from FP Reg to General Reg
Memory 1	(p) add	Predicated Add for Carry

Table 4. Montgomery Product Performance Comparison

Processor	Size	Cycles
Itanium™ processor	512-bit	245
Itanium™ processor	1024-bit	1,220

The UltraSPARC III processor has a single non-pipelined 64-bit integer multiplier, which is a significant performance inhibitor. Each multiply must wait for the previous one to complete.

The PowerPC 7400 (G4) is a 32-bit processor, but still has the power to perform small integer multiplications in the AltiVec unit. The PowerPC G4's AltiVec, or Velocity Engine, extension supports a 4-wide 16-bit multiplication instruction. Four of these instructions plus additions are needed to provide the equivalent of one 64-bit multiplication. For this reason, the performance of this processor also lags that of the Itanium processor.

The performance estimates in Table 5 attempt to reflect an upper bound of the competitive processor performance. The performance estimates were a result of theoretical analyses done without anyone actually having developed code and executed it on the processors. There may be other performance bottlenecks in the implementations, such as a lack of registers or instruction issue limitations. More details are available in Appendix 2: Competitive Analysis Using the Montgomery Product.

Conclusion

Based on current measurements, the Itanium processor 660 MHz provides substantially better performance for the RSA public-key algorithm than what we estimate current competitive processors can provide. We fully expect this performance differential to remain in place as we move toward production-level frequencies. We expect the performance of the Itanium processor 800 MHz to scale linearly from that of the 660 MHz version. Since public-key algorithms are the core of many security applications, Itanium processors should significantly benefit the performance of these applications and enable the integration of additional security features into application software without compromising server performance. This goes a long way towards eliminating the historical trade-offs that IT managers have been forced to make between security and performance.

These performance results are derived from work done at the Intel Microcomputer Labs as part of its mission to enable high-performance computing for independent software suppliers. RSA Security Inc. has committed to incorporate these performance improvements into its future products. These products are used widely as building blocks for security applications. RSA Security's leadership in the security field will help to ensure the proliferation of such performance results into the market. Already, other security suppliers have expressed interest in incorporating the results of this work into their products.

Table 5. 1024-bit Montgomery Product Performance Estimates

Processor	Montgomery Product Performance Estimate
Itanium™processor	1,220 cycles
Alpha 21264	1,800 cycles*
UltraSPARC-III™	12,300 cycles*
PowerPC G4 with AltiVec	14,000 cycles*

* estimates based on theoretical analysis of architecture

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Acknowledgments

We would like to thank the people at RSA Security Inc. for integrating our work into their future products and into a testing vehicle suitable for measuring these results.

Appendix 1: System Configuration

The system configuration used in these measurements is outlined in the following text. Measurements were made on an Intel Itanium processor 660MHz-based system with kernels from RSA Security.

Hardware

- Intel Itanium Processor
- BIOS Build 19/PAL16
- 660MHz, 133 MHz system bus, 2x bus (system bus enabled at double pump rate)
- All caches (L1, L2, L3) enabled
- 2MB L3 cache

Software

- Intel® Cross Development SDK Build 5
- Windows† 2000 NT 64-bit

Appendix 2: Competitive Analysis Using The Montgomery Product

The Montgomery Product can also be used to compare processor performance. Examining the architecture and implementation details of various microprocessors, their Montgomery Product performance estimates can be calculated. In particular, comparing the number of integer multipliers, latency of the multipliers, types of integer multiply instructions, number of ALU execution units, and number of instructions issued per clock can help in making estimates.

The performance of the Itanium processor can be compared with the performance of the following processors:

- Compaq Alpha 21264/21364 processors
- Sun UltraSPARC III processor
- IBM PowerPC 7400 (G4) processor with AltiVec (or Velocity Engine)

The following table compares the architectural features of the processors.

The Alpha architecture integer multiply instructions are similar to the ones in the Itanium processor architecture. The SPARC architecture defines only a single MULX instruction, which multiplies two 64-bit integer values and produces a 64-bit result. There is no method for capturing the upper 64 bits of the result.

The PowerPC 7400 is a 32-bit processor, but is still has the power to perform small integer multiplications in the AltiVec unit.

The implementation details of the processors also can be compared, as shown in Table 7.

The Alpha 21264/21364 has a single pipelined 64-bit integer multiplier, as compared with the Itanium processor dual pipelined integer multipliers.

The UltraSPARC III has a single non-pipelined 64-bit integer multiplier, which is a significant performance inhibitor. Each multiply takes a minimum of 6 cycles and must wait for the previous one to complete.

The PowerPC G4's AltiVec, or Velocity Engine, extension supports a 4-wide 16-bit multiplication instruction. Four of these instructions plus additions are needed to provide the equivalent of one 64-bit multiplication. For this reason, its performance also lags that of the Itanium processor.

Table 6. Architectural Feature Comparison

Architectural Feature	Itanium™ Processor	Alpha 21264/ 21364	UltraSPARC-III™	PowerPC G4 with AltiVec
Integer Multiply Instructions	XMA.H, XMA.L	UMULQ, UMULH	MULX	VMULOUH, VMULEUH
Integer Multiplication Width	64 x 64 → 64 upper/lower	64 x 64 → 64 upper/lower	64 x 64 → 64 lower only	Four 16 x 16 → 32
Integer Multiply-and-Add?	Yes	No	No	No
Number of Integer Registers	128	32	8 globals, 8 input, 8 local, 8 output	32 vector registers

Table 7. Implementation Comparison

Implementation Feature	Itanium™ Processor	Alpha 21264/ 21364	UltraSPARC-III™	PowerPC G4 with AltiVec
Instructions Per Clock	6 (4 Int/2 FP)	6 peak, 4 sustainable	4	4
Number and Width of Integer Multiplier	Two 64-bit	One 64-bit	One 64-bit	Four 16-bit
Pipelined Multiplier?	Yes	Yes	No	N/A
Int Multiply Latency	7 cycles	7 cycles	6-9 cycles	N/A
Number of Physical Integer Registers	128	80	8 global/ 24 windowed	32 128-bit

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The Intel® Pentium® III Xeon™ processors and Intel® Itanium™ processors may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

† Third-party brands and names are the property of their respective owners.

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EXHIBIT O continued

Press Releases

Intel® Architecture And Windows* 2000 Provide Building Blocks To Grow E-Business

SAN FRANCISCO, Calif., Feb. 17, 2000 - Intel Corporation today announced support for the Microsoft Windows* 2000 operating system. Intel and Microsoft Corporation have worked together to ensure that the Windows 2000 operating system is highly optimized for the Pentium® III and Pentium III Xeon™ processor platforms. Intel Architecture-based servers and Pentium III processor-based clients combined with Windows 2000 provide a balanced computing environment that easily adapts to the constant evolution of the Internet while easily powering e-Business applications and services.

"The combination of Intel Architecture with Microsoft Windows 2000 will offer businesses outstanding performance, scalability, value and breadth of solutions," said Paul Otellini, executive vice president and general manager, Intel Architecture Business Group. "Intel is committed to ensuring that this combination provides the solution of choice for businesses as they move to the next level of e-Business solutions."

"The combination of Windows 2000 and Intel Architecture on laptops, desktops and high-end enterprise servers provides a great computing platform for companies looking to Internet-enable their businesses," said Bill Gates, chairman and chief software architect, Microsoft Corp. "The Windows 2000 Server products together with Pentium III Xeon processor-based servers deliver excellent performance and value for today's e-Business environments plus headroom for future growth."

Intel Architecture-based Servers, Workstations, Desktops and Mobile

Intel Architecture-based servers with Windows 2000 provide superior performance and value for today's e-Business environment enabling IT to scale-up and scale-out affordably at the same time providing a highly available and flexible platform.

Both Intel and Microsoft drive industry standards in order to provide required server manageability features for improved server reliability, manageability and serviceability. This enables the delivery of server up-time and availability in today's 24-hour e-Business environment.

Intel's forthcoming IA-64 product line will compliment IA-32 products taking Intel Architecture to higher levels of the enterprise forming the server and workstation foundation for the Internet.

EXHIBIT R

High-speed Pentium III processors and mobile Pentium III processors featuring Intel® SpeedStep™ technology together with Windows 2000 deliver the necessary performance to meet the demands of today's e-Business requirements.

Windows 2000 is the first mobile-friendly version of Windows NT*, now enabling corporate IT to standardize on one operating system for both desktop and mobile systems.

Intel Networking
Intel® PRO/100 S Management and Server adapters support Internet Protocol Security (IPSec), which is recognized as a key network security standard for e-Business. Intel's IPSec-enabled adapters are optimized for Microsoft Windows 2000, the first operating system that incorporates standards-based IPSec. Windows 2000 helps eliminate the security processing burden on the PC's central processing unit by offloading network security functions to the PRO/100 S adapter.

Intel Communications Hardware and Software
Intel Dialogic Division is bringing telecom to IT with modular building blocks and a community of ISVs, OEMs and service providers that offer powerful solutions to integrate telecom into critical business processes. Combining Dialogic computer telephony (CT) components, Intel Architecture and CT Media™ server software with Windows 2000 accelerates the development and adoption of open CT systems, allowing the deployment of more capable solutions with minimal effort. This enables the integration of voice and data which is essential for true e-Business solutions.

Intel's Own Implementation of Windows 2000
Intel has been a key participant in the Microsoft Windows 2000 Joint Development Program for more than two years. In preparation for the release of the operating system, Intel already has several hundred client systems and dozens of servers running on Windows 2000 and has qualified it for use immediately upon release. Intel will begin a phased corporate roll-out in Q2 2000.

"Windows 2000 is strategically important for Intel for use in all aspects of our business," said Doug Busch, Intel vice president, Information Technology. "The server operating system, used with high-performance multi-processor Intel Architecture-based servers, will be a workhorse platform for our e-Business and enterprise applications. Also, the new capabilities for mobile users are important to our initiatives to improve employee effectiveness and productivity."

Windows 2000 also provides network services that will be critical building blocks for Intel e-Business, enterprise applications and productivity environments. Active Directory Services, finer -grained control of security and better control of configurations and software distribution will be very valuable to Intel.

Intel, the world's largest chip maker, is also a leading manufacturer of computer, networking and communications products. Additional information about Intel is available at www.intel.com/pressroom

mobile Pentium® II processor family

The performance you need for today's and tomorrow's mobile computing

Intel's mobile Pentium® II processors at speeds of 400, 366, 333, 300PE, 266PE and 266MHz (low voltage) bring higher performance and more efficient power consumption to mobile computing. The mobile Pentium II family of performance PC processors blends superior performance with technical innovation giving today's demanding mobile users greater functionality wherever they go. These processors incorporate state-of-the-art technologies, such as Intel's 0.25 micron manufacturing process for dramatically improved business, graphics, and communication software productivity. And, with the introduction of the 366 MHz version and the 256K on-die L2 cache technology, mobile Pentium II processors enhance performance, optimize power consumption, and ensure the efficiency of a constant computing environment.

- Mobile Processors
  - Archives
  - Application Notes
  - Datasheets
  - Design Guidelines
  - Manuals
  - Performance Briefs
  - Product Support
  - Specification Updates
- Mobile Chipsets
- Mobile Platform Technology Initiatives
  - Archives
- Mobile Platform Technical Collateral
- Business Computing

Mobile Pentium® II processors deliver more than just fast Intel® mobile processor benchmark results. They equip portable systems with the functionality

EXHIBIT R continued

Home Computing
* Where to Buy
* Wired for Management

and data capacity traditionally found only in high-end desktop systems. Through the power of these processors, active professionals can take advantage of Digital Video Disk (DVD), high-speed wireless communication, and robust multimedia technologies. Furthermore, the entire performance PC family of mobile Pentium II processors incorporates built-in features for cutting-edge manageability. Supporting Intel's Wired for Management Initiative (WfM), mobile Pentium II processor-based systems are easier to control and support, and therefore more affordable for businesses to maintain.

Advanced Mobile Technology
Take a look at the advancements enabled by this new technology:

- **400, 366, 333, 300PE, 266PE and 266 (low voltage) MHz Clock Speeds:** Mobile Pentium II processors deliver higher Intel mobile processor performance without sacrificing battery life. A mobile Pentium® II processor running at a clock speed of 366 MHz offers between 26 - 47% performance improvement over a mobile Pentium II processor at 233 MHz. [1] The 300PE and 266PE show equally impressive results when compared to the 233 MHz Mobile Pentium® II processor.

- **Half the cache size and better performance:** The 256K L2 on-die cache is half the cache size of the 512K external cache provided with previous mobile processors, but provides three times faster access and maximum power optimization.

- **BGA packaging for the lightest, thinnest notebooks ever:** To accommodate mobile PCs of various sizes, weights, and price points, mobile Pentium II processors are available in Mini-Cartridge, MMC1, MMC2, and also the BGA package. The BGA package is 60% smaller than the mini-cartridge and half of the height, allowing for an even more compact design.

EXHIBIT R continued

- **0.25 Micron Technology:** Mobile Pentium II processors are built using Intel's breakthrough 0.25 micron manufacturing process. This innovative process makes it possible for these CPUs to include up to 27 million transistors in the core-resulting in more power in less space.

- **QuickStart™ Technology:** The most powerful energy saving device is QuickStart Technology, an innovative feature of Pentium II processors. With QuickStart Technology, the processor works at a lower wattage when the system sits idle, such as when you pause to think or review information, so that the mobile PC consumes less power while it operates. The result: increased processing capabilities for more demanding business applications, without sacrificing battery life.

- **Dynamic Execution:** Like their desktop counterparts, mobile Pentium II processors combine three innovative data-processing techniques to manipulate data more intelligently and efficiently. These techniques predict and analyze software instructions to optimize processor workload.

- **Wired for Management Support:** Promoting reduced Total Cost of Ownership (TCO), mobile Pentium II processors conform to Intel's WfM initiative. These processors benefit from features such as self-testing circuitry, advanced power management, and instrumentation for system monitoring.

Constant Computing for improved productivity: Information Technology (IT) is constantly striving to improve user productivity. The excellent performance offered by the mobile Pentium II processor provides the power to do just that-by supporting a constant computing environment. In constant computing, the computer is constantly working in the background

for the user and IT. This technology can take care of such repetitive, time-consuming tasks as compressing and decompressing data to allow more LAN throughput, scanning for viruses on all incoming data, automatic encryption of communications to improve security, and smart Web data gathering functions.

Greater Functionality Mobile Pentium II processors provide performance headroom to protect mobile system investments for years to come. These processors ensure that mobile PCs are ready for today's advanced software applications, as well as tomorrow's new releases and will have the capacity to benefit from the latest emerging hardware.

Mobile Pentium II processors bring superior performance to demanding business-suite software and today's state-of-the-art operating systems. Because they integrate MMX™ technology along with increased power, mobile Pentium II processor-based systems are the best choice for delivering graphically-rich interactive presentations, producing smoothly-playing full-motion video, and processing sound/voice media while on the road.

Key Benefits

- Available at 400, 366, 333, 300PE, 266PE and 266 (low voltage) MHz for superior performance
- Mobile Pentium® II processor at 366MHz offers between 26 - 47% performance improvement over a mobile Pentium II processor at 233 MHz. [1]
- 256K on-die L2 cache increases performance and optimizes power consumption
- BGA packaging for the thinnest, lightest notebooks ever
- Enhanced computing power for business, multimedia, and remote production with processing headroom to support emerging performance and resource-intense applications
- QuickStart™ Technology, a feature of mobile Pentium II processors, conserves power, maintaining battery life
- Ready for Windows* 98, NT and Windows* 2000
- WfM-compliant to reduce TCO

Disclaimer: All processors were tested in IBM* Thinkpad* 770 with Pentium® II processor with 256K of on-die L2 cache, 64MB SRAM, DVD ROM, 440BX chipset, Trident* 9385DVD graphics controller, 8.1G hard disk drive, DirectX* 6, and Windows* 98.

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EXHIBIT R continued

executive summary

Mobile Intel® Pentium® 4 Processor – M

product overview

Intel Mobile Technology—specifically designed for mobile PCs—delivers the best mobile solution for your needs. The Mobile Intel® Pentium® 4 Processor – M offers outstanding performance and extended battery life for real-time conferencing, streaming video, graphics presentations, and other multimedia applications.

Based on advanced Intel® Netburst™ microarchitecture, the Mobile Intel Pentium 4 Processor – M incorporates sophisticated power management and packaging features that extend battery life and enable thinner, lighter systems. The following features combine to improve user productivity, efficiency, and flexibility.

Higher Performance

The Mobile Intel Pentium 4 Processor – M provides superior capabilities for multimedia and graphics-intensive applications, as well as the necessary performance for high-intensity collaboration tools such as streaming video and real-time video conferencing. Furthermore, it enables processor-intensive "background computing" tasks like compression, virus scanning, and client management. Many businesses are adopting mobile PCs for their workforce. Along with the growing need for mobility is the increasing requirement for high-performance computing.

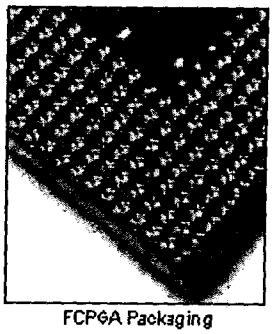
Extended Battery Life

The Mobile Intel Pentium 4 Processor – M incorporates energy-saving features that can efficiently manage power usage and significantly extend the battery life of mobile PCs.

Enhanced Intel® SpeedStep® Technology dynamically scales frequency and voltage according to how much processing power is necessary. For instance, on the average the Mobile Intel Pentium 4 Processor – M uses two watts of power by dropping to less than a volt between keystrokes then ramping up to 1.3 volts when peak performance is necessary. This real-time dynamic switching, which involves bus ratios, core operating voltage, and core processor speeds significantly extends battery life.

Another way the mobile processor maximizes battery life is with Deeper Sleep Alert State. This dynamic power management mode adjusts voltage during brief periods of inactivity—including microseconds between key strokes.

Thinner, Lighter Systems



FCPGA Packaging

Mobile Intel Pentium 4 Processor – M notebooks provide the flexibility, freedom and power to get the job done—at a desk or on the road. Innovative Micro FCPGA packaging technology allows the processor to fit into smaller form factors, including both full-size and thin-and-light notebook platforms.

This packaging makes it possible for mobile devices to be smaller, easier to use, and more capable of handling compute-intensive applications. The processor uses less power in both the performance and battery optimized modes, so it's cooler and can be used in smaller mobile PCs and devices.

Seamless Connectivity

Maintain high efficiency and productivity levels with Mobile Intel Pentium 4 Processor – M based notebooks, whether in a wired or wireless environment. The Mobile Intel Pentium 4 Processor – M provides the battery life and performance you need for demanding wireless connectivity and security applications. Studies from leading analysts show that business mobile PC users with wireless connectivity gain an additional eight hours per week of productivity compared to mobile PC users on a wired network.

The Mobile Intel Pentium Processor 4 – M enables convenient wireless connectivity by allowing you to choose advanced technologies such as LAN (802.11a and 802.11b) or Bluetooth*. 802.11a is the fastest standardized wireless technology with data rates of up to 54Mbps (versus 11Mbps with the current 802.11b standard). It enables more simultaneous wireless users and enhances mobile multimedia applications such as streaming video.

Complementing the Mobile Intel Pentium 4 Processor – M is the new Mobile Intel® 845MP chipset. The chipset provides a stable and reliable platform for the deployment of powerful mobile PCs in the enterprise, ensuring maximum ROI and headroom for the future. It also incorporates advanced power management features to help maximize battery life and on-the-road productivity.

Read the entire product overview [PDF, 62KB], titled "Introducing the New Mobile Intel Pentium 4 Processor – M."

Related Information

Invest in the Benefits of Mobility: Mobile Computing for Large Business

Mobile Computing Takes You Places: Mobile Intel Pentium 4 Processor – M

** Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

Intel® Pentium® 4 Processor
The Center of Your Digital World

Platform Support

Intel® [redacted] pset

Intel® 845 Chipset

- Unleash the full potential of the Pentium® 4 processor with dual channel RDRAM memory
- High volume and cost effective memory for mainstream applications

For Consumers

Intel's highest performing PC platform for today's high-end applications and tomorrow's demanding Internet innovations

Power for cutting-edge Internet technologies like broadband, streaming video and MP3 audio

Performance to quickly create, edit and share professional quality photos and video

The ultimate platform for an immersive 3D experience

Take interactive gaming to the extreme with amazing 3D graphics and sound

For Businesses

- Power for today's and tomorrow's leading Internet technologies (XML, Flash*, JAVA*)
- Performance to manage the information overload (e-Business applications like 3D collaboration, data visualization and information management)
- Enhanced ability to create media-intensive content
- Enables multitasking environment (background tasks like real-time virus checking, encryption, compression, e-mail synchronization)
- Power for advanced financial, scientific and engineering applications

http://www.intel.com/pentium4/index.htm

Intel® Pentium® 4 Processor
Designed to Deliver Performance Where Users Need It Most

Featuring Intel® NetBurst™ Micro-Architecture

Features	Benefits
Clock speeds of 1.30 GHz and above	Intel's fastest desktop processor brings users cutting-edge performance today and tomorrow
Advanced 400-MHz system bus	Triples the bus bandwidth for faster data transfer and improved performance on the most demanding apps
Hyper-pipelined Technology	A 20 stage instruction pipeline allows the Pentium® 4 processor to achieve the world's highest clock speeds to date
Enhanced Floating Point and Multimedia Unit	Accelerates video, graphics, image processing and scientific calculation
Second-Generation Streaming SIMD Extensions (SSE2)	144 new instructions boost performance for a broad range of applications and technologies that incorporate video, speech recognition, [redacted]

Intel Pentium 4 Processor Business Messages

Investment protection

- Provides headroom for emerging application and operation system upgrades
- Increases platform longevity to extend system life and reduce costly refreshes

Attract and retain new business

- Enables more effective electronic communications with your customers and suppliers: e-mail encryption [redacted] protection
- Make you growing business look like a large enterprise by creating professional quality product brochures and advertising

Increase productivity

- Faster system response for users of multiple applications: database management, financial analysis, inventory/purchasing

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Intel® Pentium® 4 Processor & Intel® Chipset Comparison Chart

EXHIBIT R continued

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November 18, 2002

Via Express Mail No.: EV200889162US

[redacted]

11-18-2002
U.S. Patent & TMOfc/TM Mail Rcpt Dt. #70

Commissioner for Trademarks
Box TTAB FEE
2900 Crystal Drive
Arlington, Virginia 22202-3513

RE: *Notice of Opposition*
Marks: CAVIUM
Serial No.: 76/273,475
Filing Date: June 19, 2001
Publication Date: February 19, 2002
Applicant: Caveo Networks, Inc.
Potential Opposer: Intel Corporation
File No.: 11355.0158.00US00

02 DEC -4 AM 9:30

Dear Madam:

Enclosed for filing are:

1. This letter (in duplicate),
2. Notice of Opposition (2 extra copies),
3. A self-addressed stamped postcard to evidence receipt of this Notice of Opposition.

The Commissioner for Trademarks is hereby authorized to draw on the deposit account No. 08-3038, Order No. 11355.0158.00US00/E. Heibel for any necessary fees.

Please return the enclosed postcard to evidence receipt of the Notice of Opposition.

Very truly yours,

Erica J. Heibel

Enclosure
cc: Erin Townley
Olga Rapoport